EGU2020-19591
https://doi.org/10.5194/egusphere-egu2020-19591
EGU General Assembly 2020

Last Glacial multi-decadal to millennial-scale precipitation variability inferred from Puerto Rican speleothems

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The high sensitivity of climate variability to the mean position of the intertropical convergence zone at different time scales is well known. However, due to a lack of absolutely dated high-resolution proxy records, the long-term changes in the tropical Atlantic oceanic and atmospheric circulation system prior to the late Holocene are still not well constrained. Paleo climate reconstructions and model studies suggest a very complex response of the northern hemispheric tropical rain belts in the western tropical Atlantic depending on the nature of the forcing, surface type and surrounding continent-ocean configuration.

Here we present a high resolution multi-proxy speleothem record from Cueva Larga (Puerto Rico) covering the last Glacial between 46 and 15 ka BP. Precise ^{230}Th/U-dating reveals growth rates between 50 up to more than 1000 µm/year which allow for the investigation of multi-decadal to millennial scale variability in the stable isotope (δ^{18}O and δ^{13}C) and elemental records.

The analysed proxies document a pronounced response of regional precipitation to abrupt centennial to millennial scale climatic excursions across the last Glacial, such as Heinrich Stadials and Dansgaard/Oeschger oscillations. Here, we observe a strong agreement between our paleo-precipitation reconstruction and climate proxy records which are indicative of the strength of the Atlantic meridional overturning circulation and northern hemispheric temperature changes. The coherence of speleothem δ^{18}O values with sedimentary ^{231}Pa/^{230}Th also on sub-millennial timescales supports a persistent link of regional precipitation variability to ocean circulation variability. Spectral analysis further suggests that multi-decadal to centennial variability persisted in the western tropical Atlantic hydro-climate not only during stadial and interstadial conditions, but also during the last Glacial maximum, supporting the hypothesis that the Atlantic low-latitude regions respond to internal modes of climate variability on these time scales regardless of the

global climate state.

The compilation of our dataset from Puerto Rico with other paleo-precipitation records allows for the reconstruction of past changes in position, strength and extent of the intertropical convergence zone in the western tropical Atlantic and reveal the existence of spatio-temporal gradients in response to millennial to orbital climate change.